Renewable and Sustainable Energy Reviews 16 (2012) 718–724

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Project portfolio management applied to building energy projects management system

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ARTICLE INFO

Article history:
Received 13 March 2011
Accepted 31 August 2011
Available online 5 October 2011

Keywords:
Energy
Project
Portfolio management

ABSTRACT

This paper is based on the project portfolio management technology to introduce a new energy projects management system. For the increasingly complex of current Chinese energy project management, and traditional project management system not being very good for energy projects in regulated status, this thesis put forward an energy portfolio management system using energy portfolio management technology combined with the unique characteristics of energy projects, which includes from proposition of energy projects, energy projects selection and evaluation, and then to portfolio assessment and implementation of energy projects and the assessment and control of energy portfolio implementation process. Therefore, portfolio management techniques are used in energy project management and control to solve the current complex problems of energy project management, and ensure that more energy projects meet the national and enterprise strategy.

Contents

1. Introduction

With the constant infiltration of low-carbon economy and deeply economic reform in China's power industry, energy power project management meets increasing pressure, and traditional project management tools are not able to manage energy power projects existing effectively. Many issues resulted from costs low, delay of project's progress and so on, have affected China to accelerate the pace of energy power construction, and restrict the development of the national economy. In current time, ten million kilowatt wind power-base, clean energy generated from solar photovoltaic power base, biomass energy projects of the new rural and nuclear power construction projects have been developing in China. Because of those chances large State-owned power generation groups, and even private capital investment institutions have entered the system of energy power projects management. The investors will face a wide range of problems like decision-making for investment and management portfolio of projects set and resource allocation and optimization. Traditional project management technologies will not be able to discover and corporate goals which have deviation or go beyond the ability of enterprises' implementation and control. Enterprises adopt portfolio management to use enterprise resources reasonably, and adapt to market changes, so the success rate of project implementation and their competitive advantage will be improved [1]. Especially for senior managers, how to guarantee more energy projects meet

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1364-0321/$ – see front matter
doi:10.1016/j.rser.2011.08.037

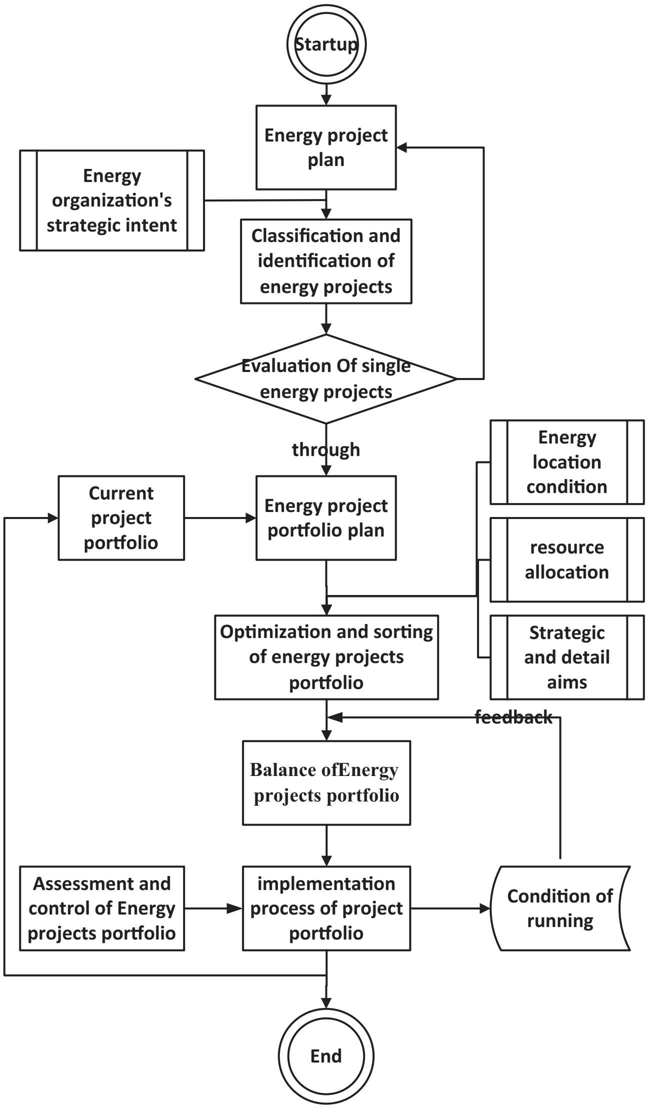


Fig. 1. Energy project portfolio management system flow figure.

the national and enterprise strategies has been a great issue in the field of project management. Therefore, it is necessary to design a new energy power projects management system which is realistic, simple, easy-to-action and can improve the efficiency.

Project portfolio management model as a new project-oriented management model just is able to adapt to current large amounts of development and application of energy project management. Develop a model to promote energy project development, and improve energy project management efficiency is wildly concerned. Take project portfolio management theory as a backdrop and combine with the characteristics of the energy projects, energy portfolio management system is design as shown in Fig. 1.

2. Classification and identification of energy projects

In energy project portfolio management system, energy projects do not only include the current projects under construction or operation, but also those have not yet started. Identification of energy projects primarily provides a particular energy project portfolio component list, which may include energy projects, energy program and other jobs. And the relationship between them is not necessarily reliant or directly related. The identification of energy project basically has the following two ways:

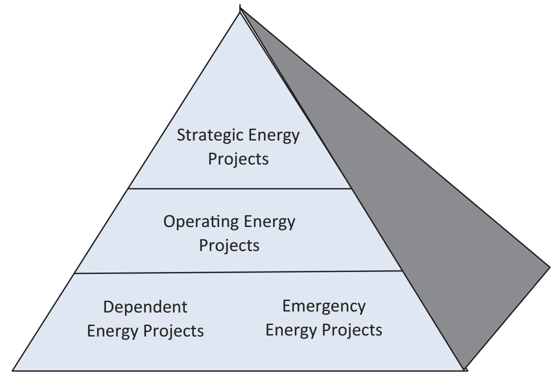


Fig. 2. Energy projects divided according to the project level in the organization.

a. According to the project-level in the organization, energy projects can be divided into dependent projects and emergency projects, operational projects, strategic projects [2]. Dependent project means a project need to run to meet the general conditions in some area, so it is known as “must do” project. For example, a region is lack of mineral resources and needs to develop wind power projects, otherwise it will affect the production and life in that region, and then wind power project is a dependent project. Rebuilding a power plant which was destroyed by fire satisfies the “must do” standard, so the project is called emergency project, which has urgent needs. Operating projects are energy projects that support the current operational needs, designed to improve system efficiency and reduce energy costs and improve performance, such as the project that a power plant providing electricity or power generation is an operating project. Operating energy projects primarily restructures energy projects in the original operation, and improve the productivity of the original. Strategic projects directly support the long-term mission of the organization, such as new energy research and development projects (Fig. 2).
b. According to the type of energy, energy projects can be divided into traditional energy projects and new energy projects, and also can be divided into intermittent and non-intermittent energy projects [3]. Traditional energy projects are technically mature projects that have been widely used, such as coal, oil, gas, water, wood, etc. New energy means all forms of energy other than traditional forms of energy, such as nuclear, solar, wind, biomass, geothermal, ocean energy, hydrogen and so on. Intermittent energy means solar and wind energy that have intermittent power generation, for example, when a cloud covered the sun, a solar photovoltaic power plant generating capacity can be reduced near zero within a few seconds, as the weather turned fine and the power output will rise rapidly. Non-intermittent energy embraces various forms of energy other than intermittent energy. As another example, thermal power generation projects belong to traditional energy, but also a non-intermittent energy projects; and wind energy is new energy project, but also intermittent energy project (Fig. 3).

According to different standards, energy projects can be divided into different types, but each has its special features, unique business characteristics and purpose. Recognizing the difference of types of energy projects is the foundation to identify energy projects of the foundation. After realizing an energy project, the enterprise should determine whether the proposed energy project and the organization’s long-term goals have the ingenerate consistency, whether the organization has the ability to afford the project, then identify the key description of project and correlation with other projects, so as to provide project portfolio with objects, which

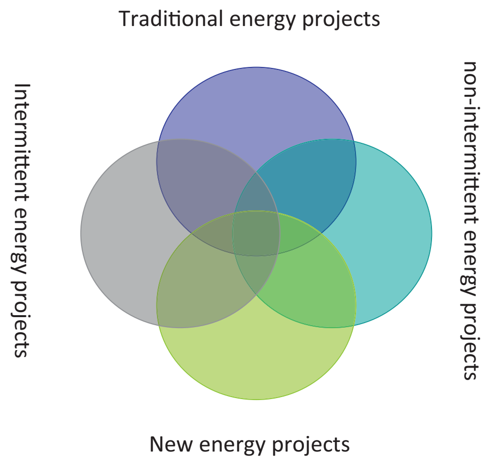


Fig. 3. Energy projects according to the kind of energy.

embrace energy projects that authorized from the previous portfolio cycle, in implementation, under management and will be invest in development.

3. Energy project evaluation and selection

After recognizing the energy project, it is necessary in the energy portfolio to evaluate and select various energy projects in energy portfolio. The evaluation and selection of energy project mainly collect and collate the information through research and expert advice, such as energy reserves, target income, human resource needs, risk factors, cost, technical feasibility, thus prepare the project plan and select the most reasonable energy project portfolio plan in a variety of project plans. Energy and power project portfolio selection process is divided into three stages: forming a collection of alternative projects; individual project evaluations; project portfolio selection, as shown in Fig. 4.

The first stage is: forming a collection of alternative projects. This stage mainly uses good project-generated mechanism to collect energy projects and build projects sets, finally to perfect the information of projects. There are three energy projects resources classes which includes corporate strategy project, business process project and employee project-recommendations. Therefore at this stage firstly it is necessary to ensure that energy companies have established a clear strategic goal and vision; and secondly establish a good project generation mechanism, through good project-generated mechanism, which is not only from the corporate strategy but also from the enterprise and staff recommendations to generate valuable projects. In addition, the project portfolio optimization and assessment must be at the complete project data base, and therefore when any set of projects was established all aspects of projects data should be collected and cleared up to get ready for the next phase project evaluation and optimum. Those data should include project objective benefits, costs and human resources requirements, risk factors, etc. The project

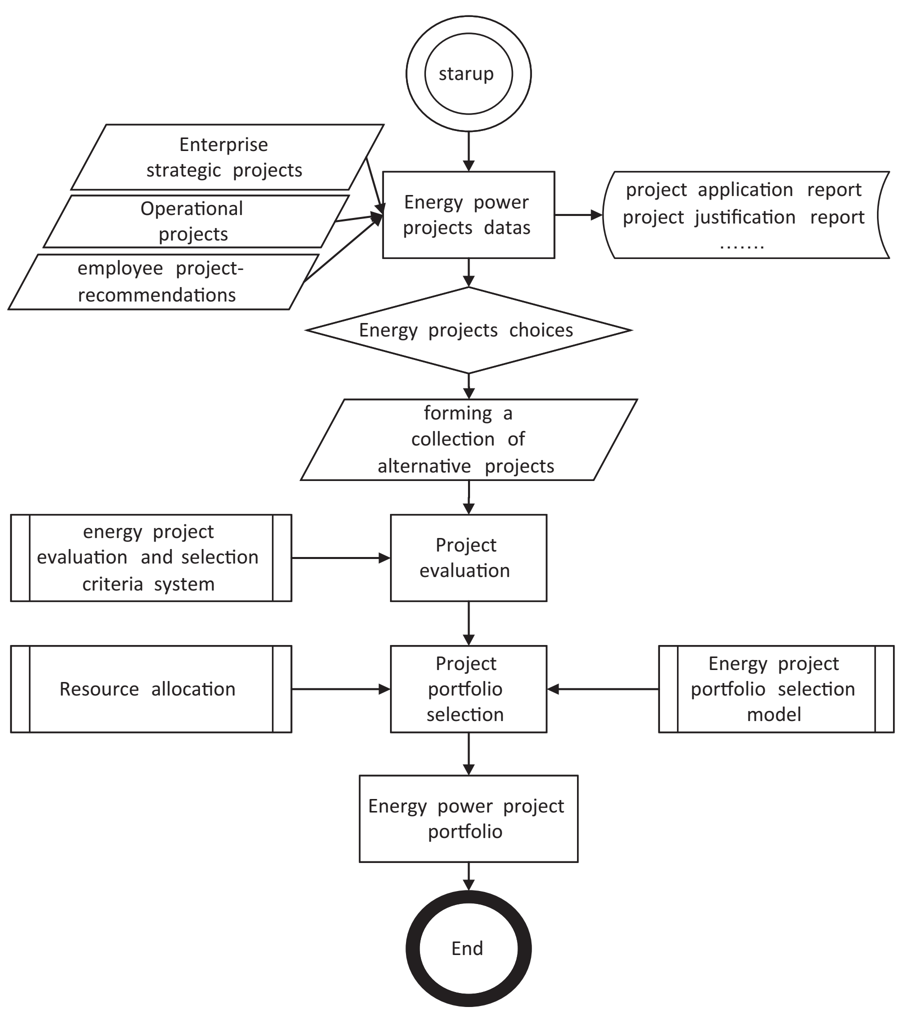


Fig. 4. Energy power project portfolio selection process.

data can be shown as project application report, project justification report.

The second stage is: individual project evaluations. In this stage project evaluation index system should be built from the perspective of single project to select the appropriate project evaluation method and the project which does not meet the method should be eliminated. The specific implementation steps are as follows:

(1) Project strategy alignment evaluation. From the angle of organizations strategic, establish evaluation index system, in which the indicators should reflect the project in line with the strategic goals as well as the extent of the projects' contribution. Then use a certain program evaluation methods for project selection and evaluation. Finally terminate the project which is not consistent with business strategy.
(2) Project comprehensive evaluation. Evaluation and selection methods of energy projects are many, but firstly energy project evaluation and selection criteria should be developed. For the General characteristics of the energy projects, standard design of energy project evaluation and selection index is shown in Fig. 5 as follows.

For these project evaluation and selection standards, it is important that the selected evaluation criteria must be developed to support the organization's strategic energy goals, for example, the impact of energy project on the regional economic development must be able to make up the region's demand for energy or increase the development and utilization technology. At present the traditional project evaluation methods, such as net present value, internal rate of return method or the dynamic investment recovery period law, almost focus on project's financial benefits and select it as the sole criterion, Therefore it is necessary to build a portfolio optimization assessment method based on traditional project evaluation method. As for energy projects which are different from general project, they has their own characteristics, such as energy projects considering its national energy security, policy and institutions, energy trading and so on. Thus environment and conditions of energy project development and implementation should be considered to build a portfolio optimization assessment method.

In project evaluation and selection of the method, the key criteria weighted scoring model is ideal for energy projects to evaluate and select [4]. The energy projects belong to energy projects, therefore they have a certain degree of comparability and we can design an energy project scoring model. Scoring model includes a series of standards expressed as a percentage and score weighted assessment criteria. Each of the standard's weight can be expressed as a percentage, and they represent the importance of the project. Each standard will be scored and score range should be defined in advance (e.g. 0 min, 5 min, 10 min). The score reflects the degree of satisfaction of standards. Each level of the score must have a clear definition, so as to ensure consistency of different projects assessment. Each of the standard's score multiplied by its weighting is the standard's value which added together to be total value. Key criteria weighted scoring model design is show as following Table 1.

The third stage is: project portfolio selection. In the stage of evaluation for single energy project, since the enterprise resource constraint was not considered, if alternative projects are too many, it does not necessarily guarantee that every right project can be selected. Project portfolio selection is to determine optimal project portfolio and dynamically manage projects of portfolio to obtain the enterprise maximization benefit according to the enterprise's resource ability. Implementation steps of this stage are as follows:

(1) Establish project portfolio selection model, and consider the interplay between the various energy projects' resources to solve model for keeping optimal project portfolio line with strategic objectives.
(2) On the basis of resource allocation, after projects' startup the project goes into the implementation phase, and achieves the resources optimal project portfolio in the implementation process. As in the project implementation process the enterprise always meets the condition that a new project is developed and the original project is not completed, so you need to re-evaluate the new project and execution of old project to timely terminate meaningless projects, and adjust portfolio.

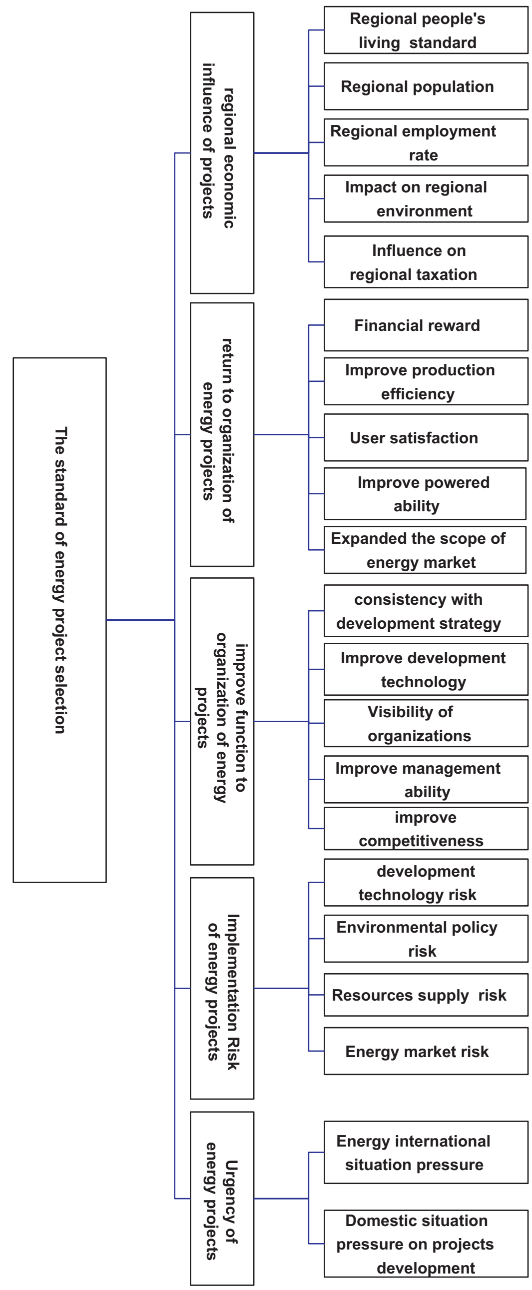


Fig. 5. The standard of energy projects evaluation and selection.

4. Optimization and sorting of energy projects portfolio

After the assessment of each energy project, select the qualified project, and combine with the previous cycle into the project portfolio management project portfolio. According to the allocation of resources, energy project types and energy organizations strategic goals class the projects in the project portfolio. The optimization

Table 1
Key criteria weighted scoring model.

Content of standards	Weights	Assessment			Score	Score with weights
		High	Mid	Low		
Standard 1						Index X
Standard 2						
Standard 3						
Standard 4						Index Y
Standard 5						
Total Weights = 100%			Total score			
			Index "X" (0–1)			
			Index "Y" (0–1)			

and sorting of energy projects portfolio is not on the prioritization of individual projects, but a good group projects to determine which items do first. There are many ways to sort projects of the portfolio.

4.1. Expected commercial value method (EVC)

ECV is a method which makes the commercial value of projects portfolio largest on the condition of budgetary constraints. EVC is built on the basis of the method of decision-making tree analysis and EVC has defined the probability of project technical success and commercial success and calculated each project's commercial value for the company which is also called by expected commercial value to order those projects and select out the project whose expected commercial value is the largest. It divides a project into several decision-making stages, such as the development phase and commercialization phase and so on. The general model of projects' ECV is as follows [5]:

$$\mathrm{ECV} = (\mathrm{NPV} \times \mathrm{SI} \times \mathrm{Pcs} - C) \times \mathrm{Pts} - D \tag{1}$$

where Pts is the probability of technical success; Pcs is the probability of commercial success; D is the cost of project for development; C is the cost of commercialization; NPV is the net present value of project's future benefits; SI is the index of strategic importance, it has three levels: high = 3, medium = 2, low = 1.

According to the value of ECV, the value of projects portfolio cannot arrive to the max and so in order to obtain the biggies portfolio value, resource constraints must be considered [6].

4.2. Evaluation index method based on multi-factors

The typical of this method is to create scoring models. In the country Fan Cunyan have raised choice model based on the strategic which is relatively large [7]. Scoring model has long been used to make decision at the decision point and project portfolio management. It first determines a series of project evaluation criteria, and then gives a score to each project, and finally obtains the total score which come from the weighted average of these scores for each item. Hoechst application scoring model is one of the best scoring models right now [8].

4.3. Expanded 0–1 quantitative portfolio model based on WBS

Change X_i of 0–1 model into the weight of some portfolio's constraints and combine the idea of WBS and project portfolio decision-making system, expanded 0–1 project quantitative portfolio planning model was proposed. The WBS with the meaning of project quantitative portfolio management was obtained and shown in Fig. 6 [9].

The benefit of project quantitative portfolio decision-making is depend on the achievement of strategic objectives on the strategic level which is finished by the completing of each project portfolio. At the same time resource constraints of each project portfolio have to weight by portfolio. Object function of expanded 0–1 model based on three-level WBS:

$$\mathrm{Max}\, W = \sum_{j=1}^{k}\sum_{i=1}^{n} X_{ji} \sum_{l=1}^{m} a_{il} x_{li}$$

Constraints:

$$\begin{cases} \displaystyle\sum_{i=1}^{n}\sum_{l=1}^{m} a_{il} x_{li} \le A_l \\ a_{il} \le b \\ x_{li} \ge 0 \\ x_{li} \le 1 \\ X_{ji} \ge 0 \\ X_{ji} \le 1 \end{cases}$$

where X_{ji} is the weight of the first level benefit index i in the project j; W is the benefits obtained by projects portfolio designed; a_{il} is the benefits value of constraint l in the first level benefit index i; b is for a_{il} the capacity of enterprise projects portfolio; A_i is the demand degree of projects portfolio for the first level benefit index i; x_{li} is the weight of constraint l in the first level benefit index i.

If the problem of projects portfolio is divided into four levels in WBS, that is, the third level constraints will be break down, we can continue to break down $\mathrm{a_{il}}$ into the formula which is similar to $\sum_{i=1}^{n}\sum_{l=1}^{m} a_{il}x_{li}$. So according to the layers of WBS, all the problems of portfolio decision-making are covered.

5. Balance of energy projects portfolio

After completion of the energy project portfolio selection sort, adjustments and balance should be done in combination with the collected energy portfolio implementation states. Through the combination of balance a perform energy portfolio can be established, which ensure that the energy portfolio have the most potential to support organizations strategic activities and achieve organizational strategic goals. Energy portfolio balance makes the organization have the ability of planning energy strategy and allocation of resources, as well as getting maximized energy portfolio benefits in the Organization predefined risk scope.

The balance of the energy portfolio should be considerate from human resources of the enterprise, their own funds, financing capacity, to technical capability, even the projects under construction together to optimize energy portfolio and improve management efficiency [10]. Energy portfolio balance includes assessment and management the competitive goals, for example, the management of energy project risks and benefits, a balanced of energy strategy objectives and short-term detailed target, the balance new energy technologies and types of projects and energy. And for the energy resources limited portfolio balance should also carry out to reflect the organization's strategic priorities. Those

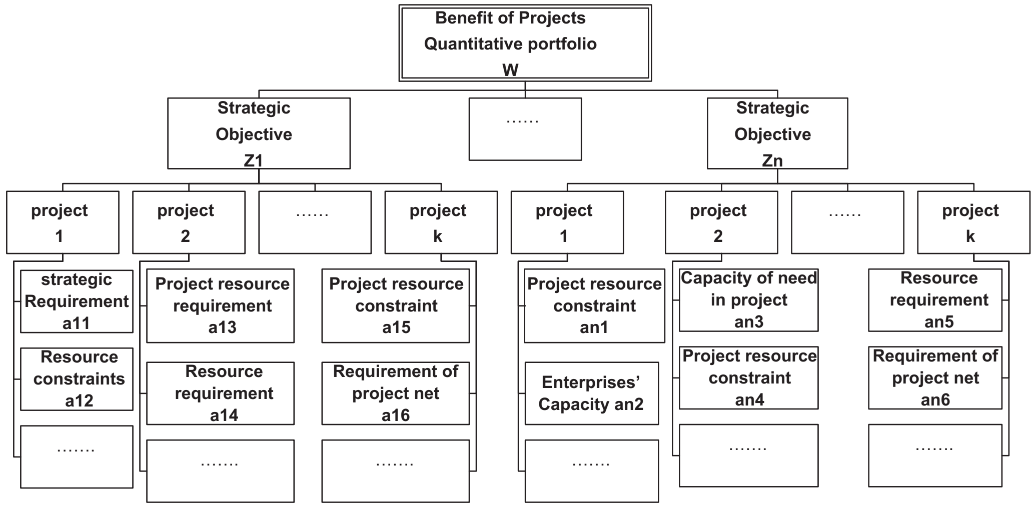


Fig. 6. WBS of expanded 0–1 project quantitative portfolio decision-making model.

projects which can only contribute to the very low efficiency should be removed from the portfolio to leave the resources to projects that have higher priority. But for those projects or project portfolio which dependent on others can be merged to ensure getting high priority portfolios includes all the dependencies. Later, portfolio should be balanced through the prior definition of portfolio management standards, organizations expect risk levels, energy portfolio performance expected, organization execution on energy projects and so on to support the strategic objectives identified. In balance and adjust the activities, the previous collection portfolio data should be referred.

6. Assessment and control of energy projects portfolio

In the implementation process of project portfolio, assessment and control of energy projects portfolio need to been done whose main purpose is to collect indicators. On the basis of assessment and control report, energy portfolio ware reviewed in accordance with predetermined cycle to ensure that the energy portfolio and strategic of energy organizations ware consistent, while resources ware also able to make efficient use. Each project or group should make a separate assessment to evaluate each project or portfolio's performance on the level of contribution to the overall portfolio, but also an overall review of the portfolio should be conducted. The purpose of accreditation is to ensure that energy strategy goals of portfolio are able to carry out [11]. Thus, according to the specific condition of projects' implementation and the national energy policy and other changes different measures can be took to the overall energy projects in the portfolio of projects or project portfolio, like add, revaluation priority or removal, etc.

Energy project portfolio control is a system management model taking work as the central. In this model organizational goals will be developed by upper management personnel with lower-level managers, as well as with staff in the organization and will special the goads to an organization or each Department, each level, each Member of project Department in order to ensure a series of checks and adjustments to implementation. According to the characteristics of energy power projects, the total target can be divided into cost management, security management, schedule management, quality management and environmental protection management goals and so on five objectives in the energy power portfolio use transverse and longitudinal zigzag supervision to project at the various stages of supervisory control. Because energy power projects

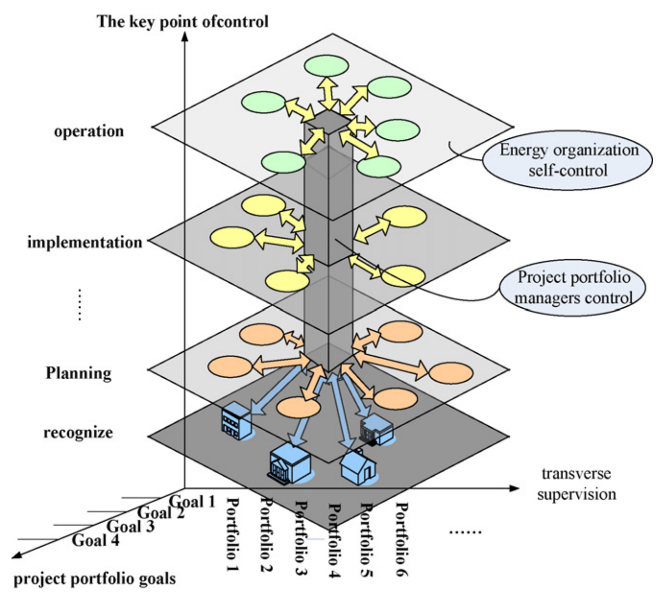


Fig. 7. Energy project portfolio control.

is the process of organize, command, coordination and control to achieve a certain goal and project implementation plan in certain constraints, periodically check the project implementation to find the problems existing and analyze the causes. At the end take corrective measures. Repeat those again until the project portfolio goals ware achieved. Energy project portfolio control can be shown in Fig. 7.

Energy power portfolio target control's main task is to adopt the planning, organization, coordination, and other means to take measures to ensure a smooth implementation of costs, security, progress, quality and environmental project objectives from organizational, technical, financial, contractual, and other aspects. In the control process, through input, conversion, feedback, contrast, correcting, and other fundamental control activities the target control is implemented until all work go towards the overall portfolio goal of projects.

7. Conclusion

This article proposes a new project management mode which solves problems of the current energy power projects management

inefficiencies. The model is based on the current Chinese actual energy power projects situation, and uses project portfolio management technology to propose a process-oriented, standardized energy power project portfolio management mode. The energy power project mode begins with how to identify, assess and select projects, and then selects the appropriate assessment and selection method to complete portfolio selection, and after that in the portfolio prioritization and optimization of resources were done. At the end the portfolio balance and control was carried out in the implementation process of project portfolio. This entire process will solve traditional energy project management process, and complete the main task – “how to choose the correct energy project”.

References

[1] Hui J, Zou J. Application of projects portfolio management in enterprise strategies diversified. Project Management Technology 2007;9:30–4.
[2] Stawicki J. Practise implementation of project portfolio. Project Management Technology 2008;6:70–4.
[3] Chen X. Energy changes destiny. Beijing: Publishing House of Xinhua; 2008. p. 50–70.
[4] Xu J, Liu J. The standard for portfolio management. 2nd ed. Beijing: Publishing House of Electronics Industry; 2008. p. 56–60.
[5] Zhaohui S. Study of project portfolio management and valuation in company. Xi’an: Northwestern Polytechnical University; 2005.
[6] Li Z. Research of optimal combination in enterprise-class project. Hunan: Hunan University; 2007, p.10.
[7] Cunyan F, Kai H. Study the relationship between project management and strategic management. Economic Forum of American and China 2004:19–26.
[8] Wang J. Project portfolio management – management model of project-oriented enterprise. Project Management Technology 2003;3:37–9.
[9] Ba Xi, Jiangshuai L, Jiali W, Yunna W. Research of WBS-based project quantitative portfolio decision-making model. Key Engineering Materials 2011:866–72.
[10] Xianjin D, shudong S, Lixiong O. Research of balance portfolio selection model for mult-phases R&D project. Beijing: Science of Science and Management of S & T; 2006.
[11] Nana X. Project portfolio management-the bridge of strategy and project. Xi’an: Xi’an University of Architecture and Technology; 2006.